Research as a Utility Hedge

Although the uncertainties occasioned by electricity deregulation put an intense focus on short-term issues, CEOs need to keep in mind the value of consortia research and development as a hedge against technology competition.

Chauncey Starr

Chauncey Starr *is founding president of EPRI (formerly the Electric Power Research Institute), where he served five years before being appointed Vice Chairman, and then to his present position as President Emeritus. From 1967 to 1973, he was Dean of the School of Engineering and Applied Science at the University of California in Los Angeles, following a 20-year career as Vice President of Rockwell International and President of its Atomics International Division. Mr. Starr has received numerous awards for his work in the peaceful uses of atomic power, including the 1990 U.S. National Medal of Technology, which recognized his founding and leadership of EPRI, as well as his contributions in nuclear power, risk assessment, and energy studies. This article is condensed from a presentation made at the* Energy Daily *Annual Conference, held Nov. 30, 2000, in Washington, DC.*

Technology research is a tenuous subject, hard to define and package, difficult to evaluate, and boring to a nontechnical audience. It is not usually a topic electric utility CEOs dwell upon. In the unstable setting utilities face today, however, participation in research and development (R&D) is not a luxury but rather a necessity for any electric utility expecting to survive the coming decades. My concern is aroused by the recent trend among many electric utilities to substantially reduce their support of long-term R&D in spite of the strong existing evidence that it is a practical and profitable hedging investment.

I write not as a representative of the Electric Power Research Institute (EPRI), but as a long-time observer of the utility industry. My views are based on my half-century experience with utilities, starting with nuclear power following World War II. I draw my specific insights on consortia R&D from the history of EPRI, a unique U.S. utility collaboration. When the industry asked me to create EPRI in 1972, the utilities were under the gun nationally for allowing massive power blackouts, and were threatened with the intervention of a new federal agency to undertake R&D for public protection. Utility leaders considered this a potential nationalization threat, the fabled "camel's nose under the tent." The industry's response was a consortium that created EPRI as its designated R&D center. In spite of initial public skepticism about its utility sponsorship, EPRI quickly established its credibility and objectivity

 © 2001, Elsevier Science Inc., 1040-6190/01/$–see front matter PII S1040-6190(01)00187-7

with government agencies, the industry's critics, and the public. It rapidly became a source of cost-effective solutions to operating problems. Because of its total system approach, EPRI provided what more narrowly focused manufacturers and government had not. While EPRI's distinctive management style and special relationships with the industry are well known, I am deeply concerned that several generations of utility executives have superseded EPRI's founders, and that the national policy lessons learned by the industry in the 1970s have been forgotten. Their importance needs to be re-emphasized.

I. The R&D Issue

I define R&D as the process that takes innovative ideas and makes them a practical resource, thus distinguishing it from the "clinical" trials that apply existing know-how to relieve on-going operation and maintenance (O&M) problems. Of course there is a continuum, as with medical research leading to health clinic practice. As with medical research, public support of electricity R&D is rarely in doubt, as it is intuitively valued for its contribution to the quality of our society. Its funding mechanism, however, has always been a policy issue in the United States, as funding determines technical directions. Under old-fashioned public utility commission regulation, electricity R&D was a small item (less than 0.5 percent of rates), and readily approved in the utility rate structure. That provided consortium funding for EPRI 27 years ago, with the utilities overseeing its operations.

Today, the uncertain framework of developing competition has blurred utilities' perception of the future, and companies mostly limit EPRI support to short-term assistance, i.e., "clinical" help for today's troubles. Funding for the longer-term breakthrough innovations and core programs that created EPRI's knowledge base is disappearing. Although EPRI membership includes 90 percent of U.S. utility kWh production, its annual utility funding has dropped 40 percent in the past six years. During this period, the allocation to long-range R&D (not related to O&M projects) has dropped 60 percent. The primary cause seems to be the discouraging time span for R&D to achieve practical use. Nurturing an applied science stimulated innovation to a first commercial demonstration may take decades, as was the case with superconductivity. Even trials of marginal improvements in existing systems may take five years or so, and 10 years to get system-wide benefits. Major innovations and new concepts take 20 to 30 years to provide full benefit of their R&D.

It was EPRI's good fortune in its early days that its funding supported a "full court press" on promising ideas.

It was EPRI's good fortune in its early days that its funding supported a "full court press" on a broad spectrum of promising ideas (initially guided by the Green Book previously assembled by utility engineers).[1] This resulted in the growth of a professional staff and a consulting network containing a wide range of specialized disciplines. Also, during the past quarter century, EPRI has developed intimate working relationships with the operating divisions of its members, providing a key technology-transfer capability for using new technologies.

The issue today is participation in such long-range R&D programs. These provide the base for near-term O&M support of EPRI members, as well as providing a repertoire of future technical options. The inherent values of such support are worth exploring. Companies are always concerned with improving O&M. However, even a short-term engineering improvement requires some utility hands-on participation in its prior development. Membership in EPRI provides immediate access to the state of the art and the earliest opportunity to try innovations. Outsiders have a delayed access of several years through conventional manufacturers' channels under EPRI licenses.

What are the major points of such EPRI experience? First, it has

© 2001, Elsevier Science Inc., 1040-6190/01/$–see front matter PII S1040-6190(01)00187-7

reaffirmed the seeding role of the applied sciences for creating portals to innovation. Many of our present practices are "first generation engineering" based on old applied science. The intuitive judgments of R&D specialists impressively contribute to innovative visions. EPRI's Roadmap, described in *The Electricity Journal* in December 1998, is a condensed version of this.[2] The need for large lumps of funding for R&D in the electricity field, comparable to the scale of the equipment involved, has become clearer. Ideas originate with individuals, but demonstrations require substantial and long-term funding, generally beyond the risk resources of any utility. A trial of a marginal operating improvement is likely to be a gamble of several $100 million. A major new technology demonstration is about 10 times that. Unlike the early history of the computer and semiconductors, the garage-scale experiment doesn't exist in the power business. Only governments, or consortia of large companies, have adequate resources for such risks. And finally, the time scales require patient investors. In spite of all these cautions, I believe R&D investments are a least-cost utility approach to hedge against many of the future uncertainties that will plague the industry. What are these future uncertainties?

II. The Shrinking Utility Space

The past has been relatively peaceful compared to the immediate future. The utilities in the last quarter century assumed that they would be viable entities decades ahead, and they expected to get the full benefits of their R&D investments. Present trends suggest that utilities may not be as free to fulfill their long-range strategies as they have in the past. Contemplating the spiritual torments the power industry is facing in the coming decades brings to mind Edgar Allan Poe's short story, "The Pit and The Pendulum," with the victim facing the "torments" of a shrinking space and a descending knife. Those torments perhaps may be deflected by technical anticipation and new options. The driving force (the pendulum) is the rapidly increasing demand for energy generally, and electricity in particular. The shrinking walls are environmental activism and public pressure for 100 percent certainty of supply. Having sold electrification, we have created a societal addiction.

Unlike computers and semiconductors, the garage-scale experiment doesn't exist in the power business.

Continuation of the past 25-year annual growth of 2.1 percent nationally would result in a 50 percent increase in electricity demand in 20 years; today's projected 3 percent annual growth would create a 50 percent increase in 14 years. In urban areas such load increases may come in 10 years. The Internet has become a burgeoning new load and electrified transportation is pending. Active conservation and demand-side management may only buy a few years' time. The transmission and distribution (T&D) networks are already overloaded. If the lights go out, the utilities will be held responsible, with again a very palpable risk of government intervention. It is worth considering what planning constraints may arise during this 20-year period to interfere with meeting the public demand for electricity.

- Uncontrollable growth of kWh demand
- Restricted rights-of way for expanding T&D systems
- Growth of environmental constraints on all effluents
- Growing need for permanent disposal of all wastes
- Increasing public resistance to power systems as neighbors
- Tightening of fuel supplies
- Need for millisecond reliability as electrification spreads
- Politicizing of energy policy
- Growing need to tutor a fearful public on "how safe is safe enough"
- Shifting of the industry's political power to the environmental movement.
- Committing early to supply additions before need develops
- Increasing delays caused by

 © 2001, Elsevier Science Inc., 1040-6190/01/$–see front matter PII S1040-6190(01)00187-7

all of the above in licensing and permitting.

- Re-regulation accompanying privatization
- Regulatory instability on allowable financial returns

At best, reducing these "torments" with temporary bandaids will add substantial increments to kWh costs. At worst, this litany of torments could result in enough regional blackouts and massive supply failures to again raise the political push to nationalize electricity supply, as it partially did in the 1960s, and which gave rise to EPRI as a policy response. More likely is the imposition of politically mandated operation. Except for the nuclear utilities, however, competitive concerns seem to have submerged utility recognition of the challenging technical commonality of many of these long-range constraints. There seems to be little awareness that they are market impediments that provide business opportunities for those who know how to reduce them. R&D might show the way, as it has in the past.

A major and continuous contribution of EPRI to the utility industry has been its availability to regulatory agencies and the public as an authoritative and objective source for factual information on the environmental impacts and risks associated with utility operations. It has thus held in check extremist attacks on the industry. The Environmental Protection Agency has used EPRI studies on chemical effluents (such as SO_X and NO_X), plume dispersion, etc. The Nuclear Regulatory Commission has depended on EPRI, through the Nuclear Energy Institute, on nuclear plant safety issues. The public fear of 60-cycle electromagnetic field (EMF) radiation from power lines, a serious national threat to the industry, was finally minimized by a massive EPRI-led research program that included all the scientists, biologists, public health authorities, engineers, and others involved in this complex public policy issue. EPRI's openness and integrity in making available the information as it developed was key to the acceptance of the final outcome. It is noteworthy that the utilities' handling of the EMF fear, managed by EPRI, has been often cited as an example of the proper method for U.S. industry to handle public environmental fears. The national value of this to the industry is obvious.

Cost-effective, large-scale storage is essential for obtaining a meaningful contribution from intermittent solar and wind power.

I believe every one of today's constraints may be amenable to some R&D relief. My faith is based on EPRI's demonstrated past success. I don't have a plan for immediately tackling these problems, some of which are under continuous study. Along with fulfilling the objectives of such ongoing projects, I offer some off-hand ideas that we might explore to open portals and fresh options.

III. Suggested R&D Portals to Future Options

- Electricity storage would be a top priority. While we have small-scale devices such as batteries and superconductive magnetic storage, these are too expensive on a large scale for anything more than niche applications. Cost-effective large-scale storage could ease many of the issues stated above. It is essential for obtaining a meaningful contribution from the intermittent solar and wind power, otherwise doomed to remain minor sources. It could play the role of hydro in leveling peak demands. It could increase system reliability. By leveling load shape, it could permit generation equipment to operate at efficient design levels, substantially reducing O&M costs. It would markedly change the economics of network power exchanges. Sadly, there is no substantive national storage program today, even though most engineers recognize the value. Large-scale cost-effective storage would revolutionize the industry's structure.
- Developing technologies for increasing system reliability. Industry studies of present system performance are now under way.
- Rehabilitation of aging

© 2001, Elsevier Science Inc., 1040-6190/01/$–see front matter PII S1040-6190(01)00187-7

plants. Meeting existing requirements will not be sufficient for EPA's exploding pollutants list.

• Development of the economic performance of advanced coal-based technologies, such as the integrated gasification combined cycle (IGCC) and pressurized fluidized-bed combustion, to provide coal the flexibility to meet future objectives. These include effluent management and carbon sequestration, in addition to producing electricity, hydrogen, and chemicals.

• Nuclear waste management (most of which is diluted with innocuous materials) would significantly contribute to nuclear power. Separation techniques such as the transmutation of radioactive fractions, should be explored. This might require a combination of fuel cycle technology and a national burial plan.

• Developing superconductive cabling and equipment to enable a local all-DC community. DC provides a more cost-effective supply for power machinery and for semiconductor equipment.

• Installing underground power corridors carrying superconductors, oil and gas, and communication.

• Exploring the management of a mix of distributed resources both regionally and nationally.

• Initiating a national grid based on power semiconductors and flexible AC transmission systems (FACTS) devices.

These are just a few examples of R&D opportunities. A comprehensive program could be derived from EPRI's Road Map for the future. EPRI has been only one of many sources of innovation, but it is unique in its knowledge of how to graft them onto the industry's anatomy. Academics have ideas but rarely can move them. The government agencies generally have not managed R&D ably, although the DOE has often been a willing partner in such programs, and its

Nuclear waste management would significantly contribute to nuclear power.

 © 2001, Elsevier Science Inc., 1040-6190/01/$–see front matter PII S1040-6190(01)00187-7

national labs have occasionally contributed. The equipment manufacturers have also partnered with EPRI when a profitable market becomes visible. EPRI's demonstrated uniqueness is its ability to bridge the contributions of all these participants.

IV. CEOs Hedge Choice

If utility companies expect to adapt and survive, they should hedge the risks of these future constraints by becoming participants in consortia R&D funding, both for near-term and long-term benefits. This is a hedge that continuously provides a diverse portfolio of technical responses. A reasonable annual level of corporate participation in such long-term R&D would be about 1 percent of annual kWh sales, with about half going to EPRI and half within the company for staff participation in applying new technology.

This is a policy commitment that can only be made at the chief executive officer level because it involves a strategic gamble on the future. The operating levels of management in most utilities aren't given such responsibility or authority. Looked at from the CEO's perspective, this level of participation in EPRI's consortium is an inexpensive way to beat (or at least keep up with) technology competition. It could assist cost-competitiveness and survival. It's hard work to be among the leaders, but that effort is better than the alternative of inactive delay. There are examples of both in our industry's history.

As an example of such hedging, EPRI's 25-year performance has shown that it is a low-risk and high-payout R&D investment, with both continuous and long term benefits. An impartial study has shown that the utilities' past investments in EPRI have averaged a 70-fold return (equivalent to 18 percent annually).[3] The annual value of the continuing benefits has usually exceeded the

annual costs of the participating utilities. So the hedge quickly shows a net profit. The nuclear utilities have long demonstrated these benefits. The usual precautionary concern with the mix of public and investors' interests has been historically balanced. The "due diligence" of protecting and sharing proprietary rights, equality of opportunities, avoidance of unfair advantages and freeloaders, etc., has already been resolved in existing arrangements.

I've tried to suggest long-range R&D as a cost-effective aid for riding on the wave of the future rather than to risk being inundated and wiped-out. Participation in the industry's common R&D interests affirms one's corporate mission, is in stockholders' financial interests, and adds to stockholders' confidence in managerial foresight. Most importantly, there would be ready access to advanced technology experience when an unexpected emergency occurs.

I have used EPRI as a surrogate for the energy industry. My faith in the intrinsic value of R&D applies to all energy forms. I remember as a child replacing the Welsbach mantles in the gaslights of my home. Electricity brought more than a revolution in lighting. Electrification also radically changed the structure of our production industries, our economy, and our quality of life. The history of electrotechnology shows innovation leading to more innovation, in both supply and end-use. The process seems slow because the capital investment turnover rate is measured in decades, but over a single lifetime the changes are impressive. In this continuing transformation, R&D has been a key stimulus. That is the basis for my faith in electrification, and in the R&D frontier. ■

Endnotes:

1. Electric Research Council, *Electric Utilities Industry Research and Development Goals through the Year 2000*, No. 171, June 1971 (out of print).

2. Kurt Yeager, Stephen Gehl, Brent Barker, and Robert Knight, *Roadmapping the Technological Future of Electricity,* Elec. J., Dec. 1998, at 17–31.

3. *The Value of EPRI R&D: A Draft Summary of Findings Based on Analysis of the (EPRI) Innovators Series* (of utility documented applications), Bevilacqua-Knight, Inc., Oct. 19, 1995.

© 2001, Elsevier Science Inc., 1040-6190/01/$–see front matter
PII S1040-6190(01)00187-7